Hydrogen Ship
Technology Center
Pusan National University

Research & Administration Building | 2, Busandaehak-ro 63beon-gil, Geumjeong-gu, Busan, Republic of Korea
(Pusan National University, Building 206 (Engineering Hall No. 11), Room 406)
Test & Research Building | 2-1, Sinseon-ro, Nam-gu, Busan, Republic of Korea
Hydrogen Ship Technology Center | TEL : +82-51-510-7737 / FAX : +82-51-980-0788 / E-mail : hydrogenship@pusan.ac.kr hydrogenship.pusan.ac.kr

HYDROGEN SHIP TECHNOLOGY CENTER



Hydrogen Ship
Technology Center
Pusan National University

Hydrogen Ship Technology Center



HSTC

The **Hydrogen Ship Technology Center** (HSTC) is **Korea's first** university-based research institution specializing in **eco-friendly ship technologies**.

Building upon unparalleled expertise and track record in LNG carrier cargo containment systems operating at −163℃, HSTC secures core elemental technologies for hydrogen-powered vessels, including liquid hydrogen application technologies at −253℃.

The Center serves as a think tank for eco-friendly ship core technologies by establishing dedicated testing facilities and conducting demonstration projects.



Center Overview

| Mission |
Realization of a clean society through securing world-class eco-friendly ship technologies

| Technology Areas |
Cryogenic evaluation of materials and components, performance evaluation of hydrogen fuel cells and electric propulsion systems

| Key Activities |
Establishment of hydrogen ship performance evaluation platforms, core technology R&D, strategic planning, and industrial support framework development

Center Location

| Research & Administration Building |
2, Busandaehak-ro 63beon-gil, Geumjeong-gu, Busan,
Republic of Korea (Pusan National University, Building 206
(Engineering Hall No. 11), Room 406)

| Test & Research Building |
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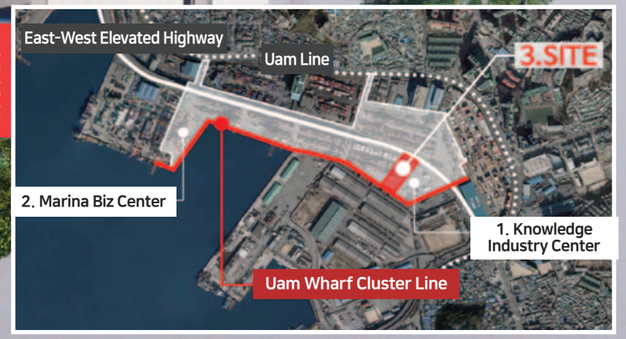
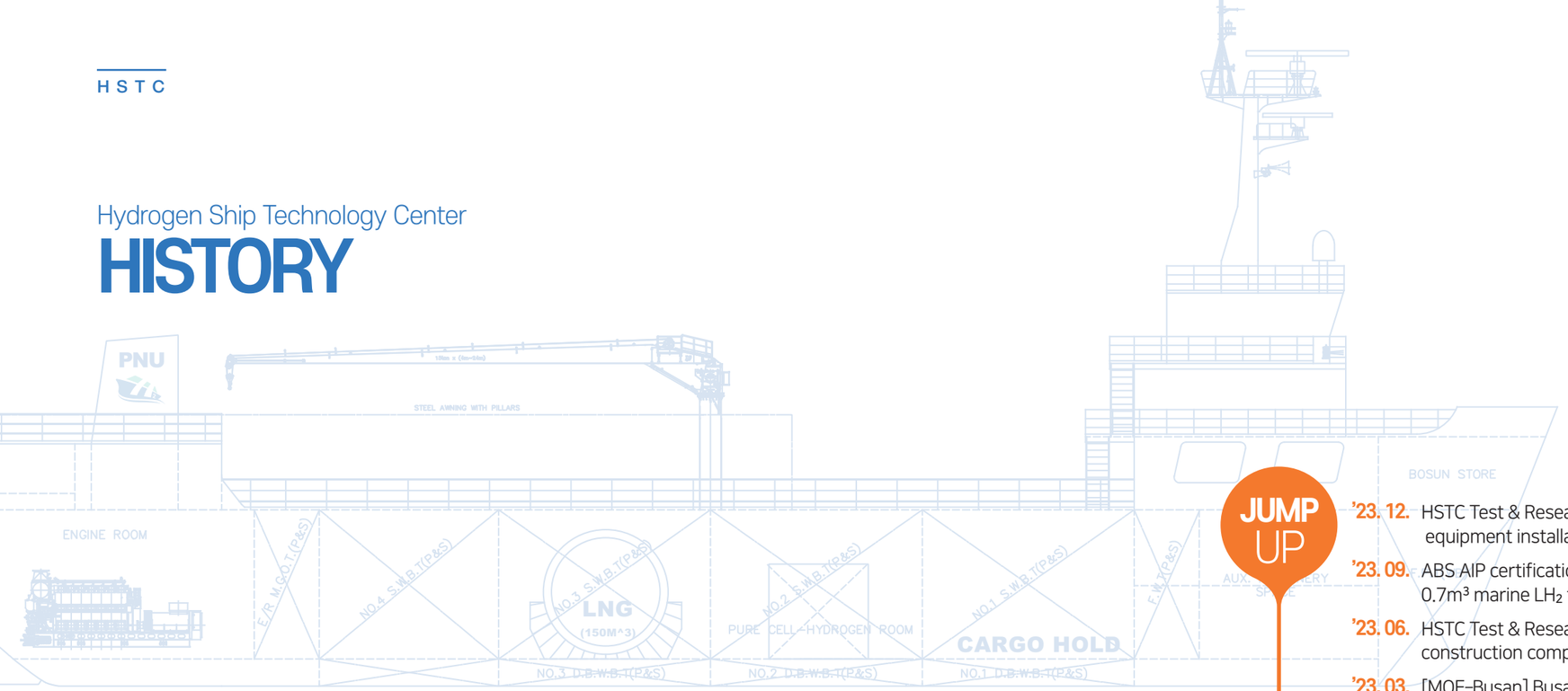
Location



Hydrogen Ship Technology Center

HISTORY



START UP

'19. 08. Renamed to "Hydrogen Ship Technology Center"

'19. 06. [MOTIE] Eco-friendly H_2 Fuel Ship R&D Platform Project commenced

'18. 06. Public hearing on Eco-friendly Smart Ship R&D Platform

'15. 12. Establishment of Cryogenic Materials Research Lab

BUILD UP

'21. 11. 2nd Hydrogen Ship Technology Forum held

'21. 10. [MOTIE] Cryogenic insulation & vessel evaluation technology for commercial LH_2 storage

'21. 02. [MSIT] Eco-friendly vessel for marine floating debris collection & treatment

'21. 01. [MOTIE] Eco-friendly H_2 fuel ship R&D platform test facility construction

'20. 11. Inaugural assembly of H_2 Ship Technology Forum

'20. 04. [MOF] Marine H_2 storage vessel & fuel supply safety standards development

JUMP UP

'23. 12. HSTC Test & Research Building equipment installation completed

'23. 09. ABS AIP certification obtained for 0.7m³ marine LH_2 fuel tank

'23. 06. HSTC Test & Research Building construction completed

'23. 03. [MOE-Busan] Busan Hydrogen Shared University Program commenced (RIS*)
*RIS (Regional Innovation Strategy based on Local Government-University Cooperation)

'22. 12. 3rd Hydrogen Ship Technology Forum held

'22. 11. [MOTIE-Busan] Hydrogen ship big data platform project commenced

'22. 07. [MOTIE] Dedicated materials & equipment for marine LH_2cargo containment

'22. 04. [MOTIE] LH_2 storage system standardization for commercial H_2 vehicles
[MOTIE] Mega convergence graduate program for LH_2 storage & operation
[MOTIE-Busan] Eco-friendly vessel for marine debris collection & treatment
[MOF] Small H_2-propelled vessel technology development & demonstration

'22. 01. [Samsung Heavy Ind.] Insulation system development for LH_2 storage vessels

GROW UP

'26. 05. Held the Plaque Unveiling Ceremony for the Lloyd's Register (LR) Global Collaborative Technology Research Center

'25. 12. Successfully Completed Korea's First Demonstration of a 10 m³-Class Liquid Hydrogen Fuel Tank for Ships

'25. 10. KOLAS accredited testing laboratory certification obtained

'25. 04. [MOTIE] Thermal insulation evaluation & safety standards for LH_2 terminal storage tanks project - participated

'24. 10. [MOTIE] Cryogenic piping for LH_2 carrier transport systems project commenced

'24. 09. Eco-friendly H_2Fuel Ship R&D Platform grand opening

[MOTIE] Commercialization technology for LH_2carriers project commenced

'24. 07. [MOTIE] Retrofit design & performance evaluation for marine LH_2 storage commenced

[MOTIE] Centralized management system for LH_2 storage vessels - participated

[MOTIE] MW-class coastal vessel electrical components & performance evaluation - participated

'24. 04. [MOTIE] Marine LH_2 demonstration facility construction project - participated

'24. 01. [MOTIE] Shipbuilding & Marine Future Innovative Talent Development Center Project - participated

MOU

MEMORANDUM
OF UNDERSTANDING



'26. 05. [PNU · Lloyd's Register (LR) · HMM · Busan Institute of Science and Technology Advancement (BISTEP)] Maritime Transport of Liquid Hydrogen and Marine Industry Cooperation - MOU Signed

'26. 04. [Lloyd's Register (LR)] Joint Development Project for Classification of Liquid Hydrogen Vessels and Equipment - MOU Signed

'25. 12. [PNU · Hyundai Motor Company · HD Korea Shipbuilding & Marine Engineering] Cooperation on Development and Commercialization of Marine PEMFCs - MOU Signed
[Korea Automotive Technology Institute (KATECH)] Cooperation on Technology Development and Demonstration for the Full Hydrogen Industry Lifecycle - MOU Signed
[Korea Aerospace Industries (KAI)] Joint Research Cooperation in Liquid Hydrogen and Aerospace Sectors - MOU Signed

'25. 04. [ABS] Joint R&D on LH_2 carriers & cryogenic equipment - MOU signed
[Lloyd's Register (LR)] Joint Research and Technology Development of Liquid Hydrogen Carriers and Cryogenic Engineering - MOU Signed
[HSTC, Panasia, Busan TP, et al.] H_2 technology cooperation ecosystem - MOU signed
[Busan Metropolitan City Office of Education] Promote Future Science Education - MOU Signed
[KIMS] LH_2 & cryogenic technology cooperation - MOU signed

'24. 02. [PNU, Busan H_2 Alliance, Busan TP, et al.] H_2 industry & workforce development - MOU signed

'23. 06. [Indonesia] Shipbuilding & marine cooperation (PNU–Indonesian MOF) - MOU signed

'23. 01. [Busan City] Eco-friendly H_2 fuel ship R&D platform - MOU signed

'22. 01. [SAMWOO MCP] Industry–academia business collaboration - MOU signed

'20. 08. [Sejin Heavy Ind.] Joint industry–academia research lab - MOU signed

'19. 10. [Korea Carbon] Core technology for cargo containment insulation & composites - MOU signed

18. 06. [Woodside, Australia] Joint R&D on LH_2 storage & transport - MOU signed

Hydrogen Ship Technology Center

HISTORY

2018.06.25.
Woodside–HSTC MOU Signing Ceremony





2023.06.02.
PNU–Indonesian MOF MOU Signing Ceremony





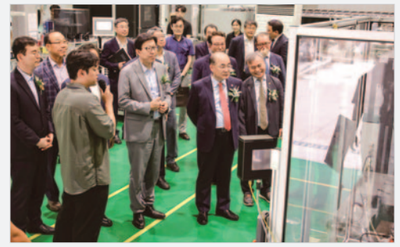
2024.02.05.
Busan Hydrogen Shared University MOU Signing Ceremony





2024.09.20.
Eco-friendly H_2 Fuel Ship R&D Platform Grand Opening





Hydrogen Ship Technology Center

HISTORY

2024.12.17.

LH_2 Carrier 'Hydro Ocean K' Kick-off Meeting





2025.02.25.

2025 1st Regional R&D Field Tour with Civic Organizations



2025.04.01.

ABS-HSTC MOU Signing Ceremony





2025.04.16.

LR-HSTC MOU Signing Ceremony





2025.04.16.

KIMS-PNU MOU Signing Ceremony





2025.04.22.

Hydrogen Technology Cooperation Ecosystem Establishment MOU & Hydrogen Forum





2025.04.24.

Busan Metropolitan Office of Education-HSTC MOU Signing Ceremony





2025.05.09.

LH_2 Carrier (LH_2C) Public-Private Joint Task Force Launch Ceremony



Hydrogen Ship Technology Center

HISTORY

2025.12.02.

PNU-HMC-HD KSOE MOU Signing Ceremony





2025.12.08.

PNU-KATECH MOU Signing Ceremony





2025.12.23.

Korea's First 10m³-Class Marine Liquid Hydrogen Fuel Tank Demonstration Showcase





2025.12.30.

PNU-KAI MOU Signing Ceremony





2026.04.10.

PNU-LR MOU Signing Ceremony





2026.05.26.

Plaque Unveiling Ceremony for the PNU-LR Global Collaborative Technology Research Center





2026.05.26.

PNU-LR-HMM-BISTEP MOU Singing Ceremony





KOLAS Accredited Testing Laboratory

국가공인시험기관
(인정번호:KT1301)

HSTC is a KOLAS-accredited testing laboratory, officially recognized by the Korean Agency for Technology and Standards (KATS) under the Framework Act on National Standards and KS Q ISO / IEC 17025 for its quality management system and testing competence.

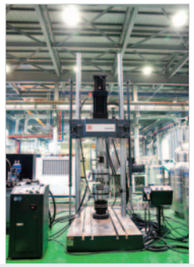
KOLAS Accreditation Scope

01. Mechanical Testing _ 01. 001. Metals and Related Products



Accreditation Certificate


Fatigue Testing Machine (10 tons)


Fatigue Testing Machine (50 tons)

Standard Number	Product and Quality	Standard Title	Test Scope	Business Site	On-Site Testing
ASTM E1450-24	Hydrogen Ship Machinery and Equipment	Standard Test Method for Tension Testing of Structural Alloys in Liquid Helium	Load : 0-490 kN Elongation : 0-99% Reduction of Area : 0-99%	Location	N
KS B 0802:2003		Tensile Test Method for Metallic Materials			

KOLAS Testing Procedure

Testing Consultation & Application
- Testing inquiry and application
  - Test schedule and availability
- Submission of test request form and required documents (e.g., procedures, drawings, and related documents)

Review of Test Request & Test Method
- Review of the test request
  - Applicable test standards
  - Applicant requirements
  - Testing fees

Testing & Issuance of Test Report
- Conduct testing
- Prepare the test report upon completion of testing
- Issue the official test report

Advancing LH_2 Demonstration and Commercialization through Korea's Regulatory Sandbox

Regulatory Sandbox Project Development and Performance Verification of Liquid Hydrogen Storage Tanks for Hydrogen-Fueled Ships.

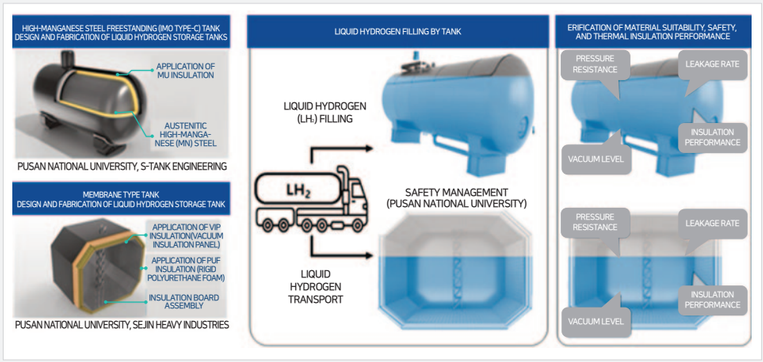
Overview Performance verification of prototype liquid hydrogen storage tanks through demonstration testing for small- and medium-sized hydrogen-fueled ships.





Regulatory Sandbox Project Thermal Insulation Performance Evaluation Platform for Liquid Hydrogen Cargo Tanks for Hydrogen Transport Ships.

Overview Fabrication of Type-specific Prototypes of Liquid Hydrogen Cargo Containment Systems and Thermal Performance Evaluation of Insulation Materials for Large-scale LH_2 Carrier Development.



Development of Core Technologies for the Commercialization of LH_2 Carriers

- **Budget** : KRW 250 billion
- **Supervising Ministry / Lead Institution** :
MOTIE / Pusan National University and 61 institutions

LH_2 Carrier Design, Shipbuilding, and Demonstration Project

Development of an Advanced LH_2 Carrier for Future Hydrogen Transport

2024.10. ~ 2028.12.
(52 months)

- 2,000m³-class liquefied hydrogen carrier design & shipbuilding technology development
  - Design and construction of core systems and liquefied hydrogen carrier
- 2,000m³-class liquefied hydrogen carrier sea trial & demonstration technology development
  - Onshore / offshore demonstration evaluation criteria & procedures for core systems and test vessel

LH_2 Carrier Design / Shipbuilding Technology and Demonstration Evaluation Development

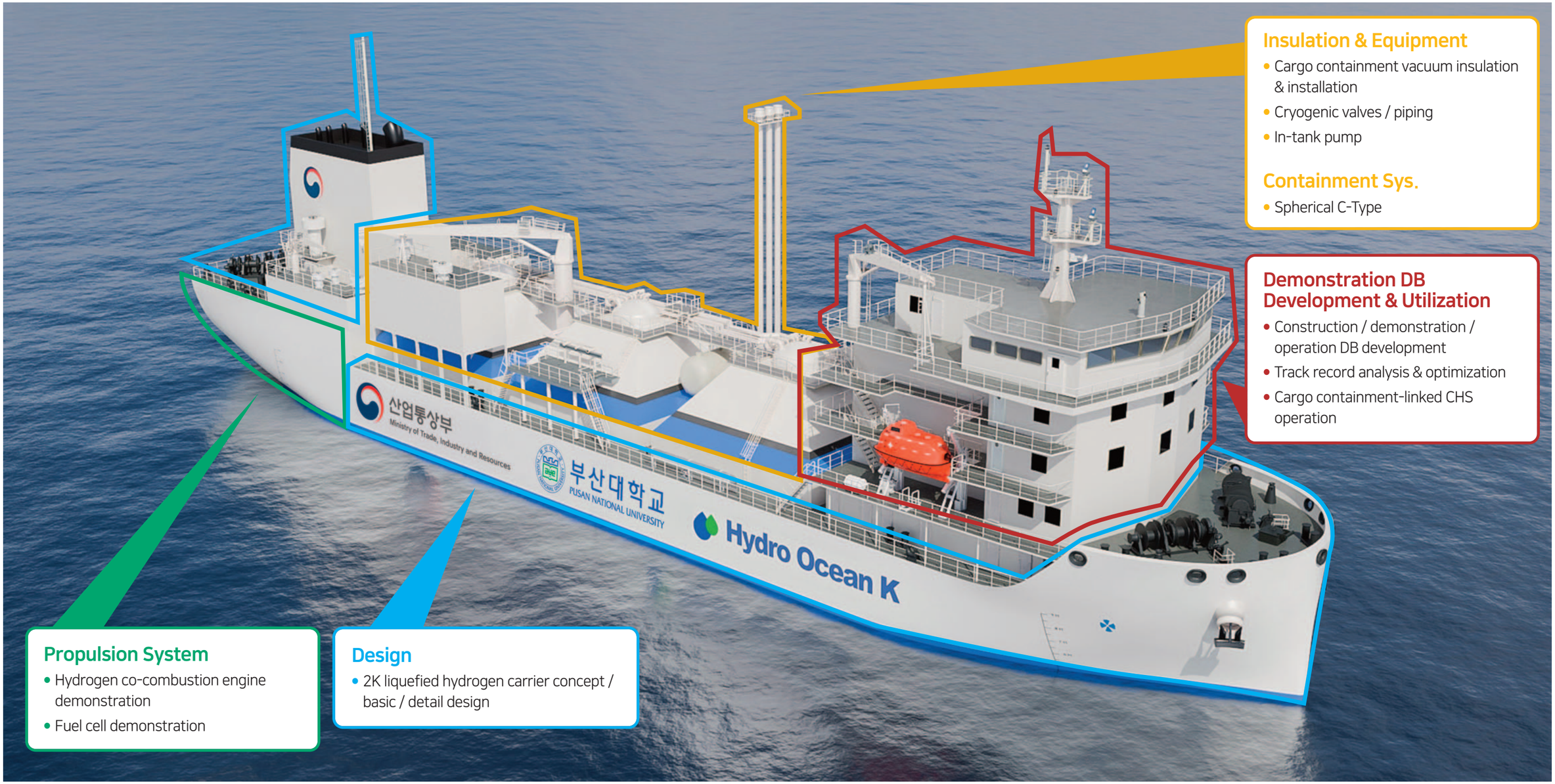








LH_2 Carrier Design, Construction, and Demonstration Project |



LH_2 Carrier Design, Construction, and Demonstration Project Consortium Structure |

Pusan National Univ.
Test ship construction management & exemption securing

KmsEmec
Design & construction spec. preparation

Movena Korea
Design review, approval & construction supervision

MACRYO
Safety technology support & equipment evaluation technology analysis

Inha Univ.
Propulsion system performance evaluation & operation plan proposal

Big 3 Shipbuilders
(Hanwha Ocean, HD Hyundai Heavy Industries, Samsung Heavy Industries)
2,000m^3 class test ship design, construction, outfitting



1 Subproject Design & Construction Technology Development

2 Subproject Sea Trial Demonstration

Big 3 Shipbuilders
(Hanwha Ocean, HD Hyundai Heavy Industries, Samsung Heavy Industries)
Sea trial & performance verification support

Korea Gas Safety Corporation
Safety standards development / improvement & safety review

Gyeongnam Techno Park
Supply chain planning & bunkering scenario development

KOMERI
(Korea Marine Equipment Research Institute)
Commissioning procedure development & results review

Korean Register
Commissioning / test criteria & legal / regulatory review

RIMS
(Research Institute of Medium & Small Shipbuilding)
Commissioning / test procedure development & commissioning

LH_2 Carrier Design, Construction, and Demonstration Project Roadmap |

2025 2026 2027 2028 2029

Concept Design

Construction Spec.

Basic Design

Ship Construction

S/C K/L L/C D/L

Cargo Containment Layout Design

Detail Design

Ecosystem project evaluation support

Ecosystem project schedule coordination / design revision

Core equipment / cargo containment installation

Component property evaluation support

LH_2 utilization evaluation support

Component / equipment integration

GROUP 1. Core Components

- LH_2 measurement sensors
- Cryogenic piping system core components

GROUP 2. Core Equipment

- LH_2 cryogenic pump
- LH_2 cryogenic dual-pipeline

GROUP 3. Containment Sys.

- LH_2 vacuum insulation system (Containment Sys.)
- LH_2 cargo handling system (CHS)

Ship outfitting design sharing

Ship operation plan sharing

Measurement sensor (Monitoring) setup

Eco-Friendly Hydrogen Fuel Ship R&D Platform Establishment Project

2019. 06. ~ 2023. 12.(55 months)

Project Operation

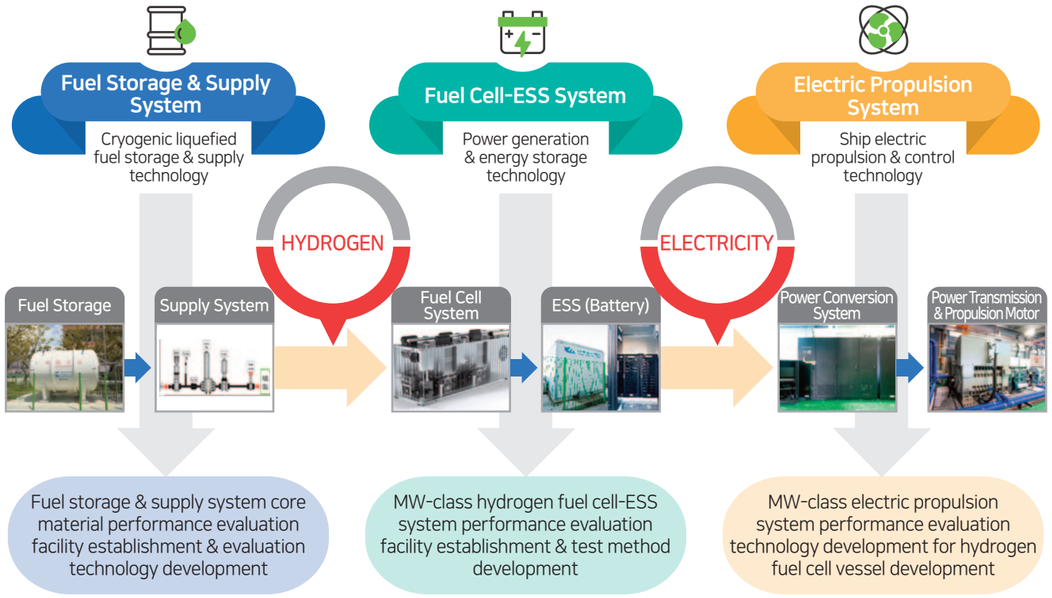
- **Budget** : KRW 40.5B (Government : 26.0B, Municipal : 12.4B, Private: 2.1B)
- **Supervising ministry / Implementing agencies** : MOTIE / Pusan National Univ. + 15 partners

Objectives

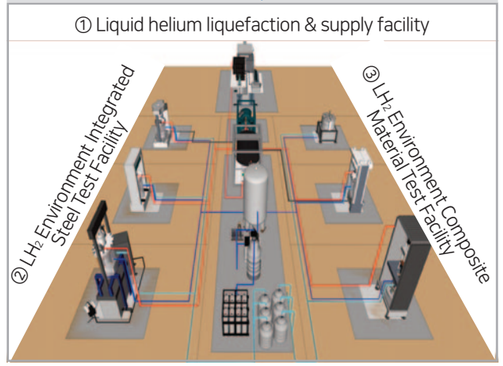
- Development of Three Core Systems for Hydrogen Fuel Cell-Powered Ships, Establishment of Test Facilities, and Development of Performance Evaluation Technologies
- Consisting of fuel storage & supply, fuel cell-ESS, electric propulsion systems

Project Scope

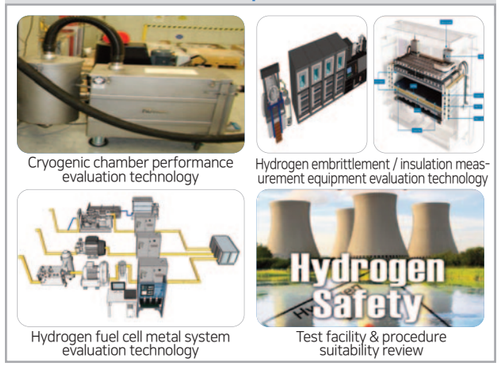
- **Target system** : Hydrogen fuel cell vessel propulsion system (1MW-class PEMFC)
- **Application** : Hydrogen fuel cell ships, hybrid propulsion ships, coastal passenger ships, etc.



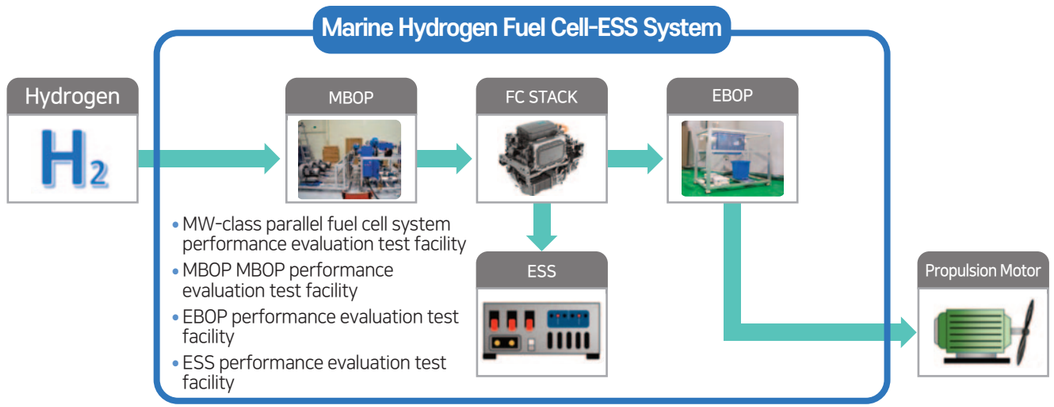
Fuel Storage & Supply System Performance Evaluation Facility Establishment



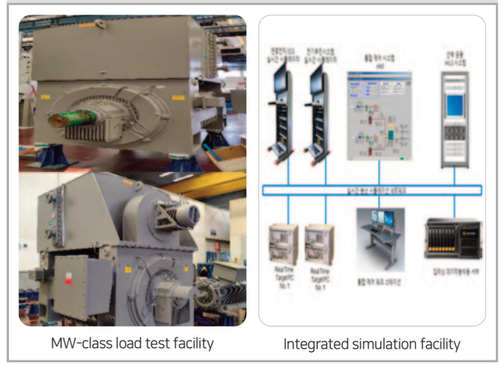
Design & Performance Evaluation Technology Development



Marine Hydrogen Fuel Cell-ESS System



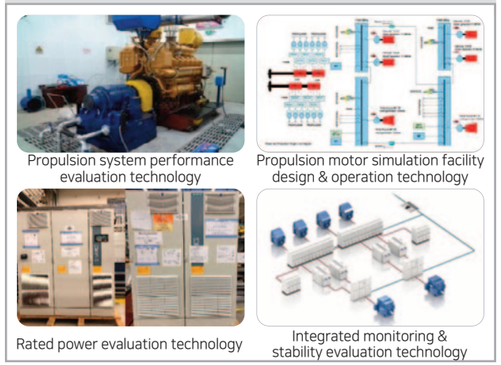
MW-class Electric Propulsion System Performance Evaluation Facility Establishment



MW-class load test facility

Integrated simulation facility

Design & Performance Evaluation Technology Development



Propulsion system performance evaluation technology

Propulsion motor simulation facility design & operation technology

Rated power evaluation technology

Integrated monitoring & stability evaluation technology

Equipment Introduction

Steel / Composite Integrated Test Facility

- Steel & composite material performance evaluation under ambient / cryogenic conditions
- Test types : Tensile, compression, shear, bending, fatigue, impact
- Test temperature : −253℃ ~ 100℃





LH_2 Environment Steel Integrated Test Facility
- (Static test) 1,000kN & 500kN
- (Fatigue test) ±500kN
- (Dynamic test) 30kN

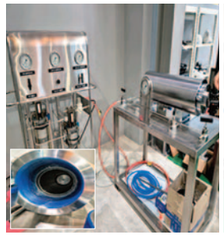



LH_2 Environment Composite Integrated Test Facility
- (Static test) 100kN
- (Fatigue test) ±100kN
- (Dynamic test) 1,800J

Advanced Hydrogen Embrittlement Prevention Measurement Facility

- Hydrogen permeation, charging & charge volume measurement

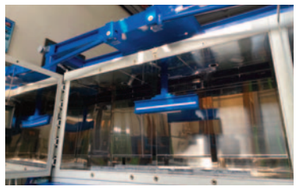
Advanced Hydrogen Embrittlement Prevention Measurement System
- (High-pressure hydrogen) 700bar
- (Electrochemical) Test temperature : −253℃ ~ 100℃





Insulation Material / Panel Test Facility

- Structural unit compression & bending test
- Low-temperature thermal conductivity measurement facility
- Material unit dynamic property evaluation facility
- Insulation panel structural integrity evaluation facility



Insulation Panel Cryogenic Performance Evaluation Facility
- Structural unit compression,bending
- Facility capacity : 1,000kN



Insulation Material Thermal Conductivity Measurement Equipment
- Low-temperature thermal conductivity measurement
- Measurement range : 0.002~2W/mK

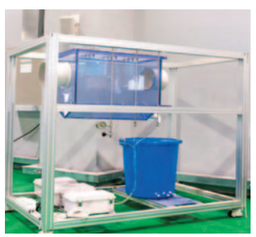


Composite / Insulation Panel Drop-Weight Impact Tester
- Mass 680kg (Max.), 3.5m (H)
- Max. energy : 23kJ

Hydrogen Fuel Cell-ESS Test Facility



Fuel Cell System Performance Evaluation Facility
- Fuel cell system power evaluation : 100~500kW
- Dynamic characteristic reproduction : > 0.5ton
- Air flow field evaluation : > 1,200Nm³/hr

MBOP Performance Evaluation Test Facility
- Max. hydrogen supply : 600Nm³/hr
- Max. air supply : 3,000Nm³/hr
- Chlorine measurement : < 0.01ppm



EBOP Performance Evaluation Test Facility
- Power converter : < 500kW
- Fuel cell output : > 220V (AC)
- Converter output : > 220V



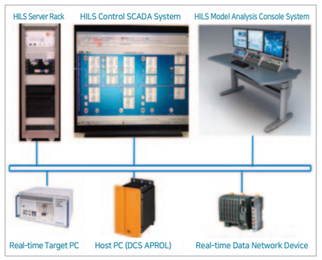


ESS Performance Evaluation Test Facility
- Capacity : < 500kW
- Rated voltage : < 1,000V
- Rated current : < 500A

Electric Propulsion System Test Facility



MW-class Electric Propulsion Load Facility
- Load motor rated capacity : 2MW
- Rated torque : > 1,500Nm
- Rated speed : 1,200RPM



HILS-based Integrated Simulation Facility
- HILS Software
- HILS Interface

Marine LH_2 Cargo Containment System Development & Demonstration Project

2022. 07. ~ 2026. 12.(54 months)

Project Operation

- **Budget** : KRW 26.3B (Government : 19.5B, Private : 6.8B)
- **Supervising ministry / Implementing agencies** : MOTIE / Pusan National Univ. + 15 partners

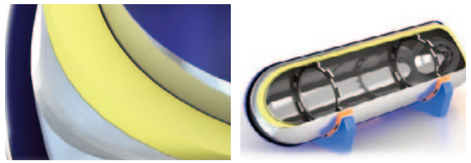
Objectives

- Large-capacity LH_2 storage & transport technology development (hydrogen shipl)

Project Scope

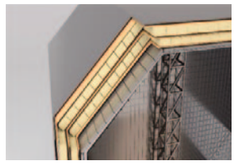
- Mechanical & thermal performance evaluation under cryogenic temperature conditions
- 70m³-scale LH_2 storage system design, fabrication & performance verification (C-Type & Membrane-Type)
- Storage tank boil-off rate, structural safety, insulation performance & vacuum retention time verification

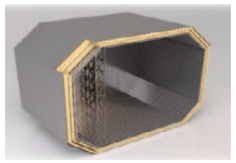
70㎥ IMO Type-C LH_2 Tank



- **Steel :** High-Mn steel
- **Insulation :** MLI-SOFI vacuum insulation system

70㎥ Membrane Type LH_2 Tank





- **Steel :** Stainless steel (304L, 316HN)
- **Insulation :** VIP-RPUF insulation system

Project Overview

Step 1. Cryogenic Design

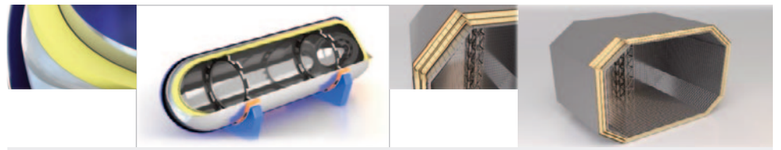
- Hydrogen embrittlement verification of applied steel
- Vacuum insulation core material development
- Performance verification at cryogenic temperature of 20K



Thermal & mechanical performance verification (20K environment)

Step 2. LH_2 Containment Sys. Mock-up Fabrication

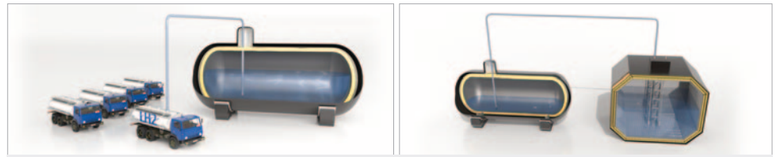
- LH_2 containment sys. mock-up fabrication
- Classification society certification & permit acquisition



LH_2 storage mock-up concept

Step 3. Performance Verification in LH_2 Environment

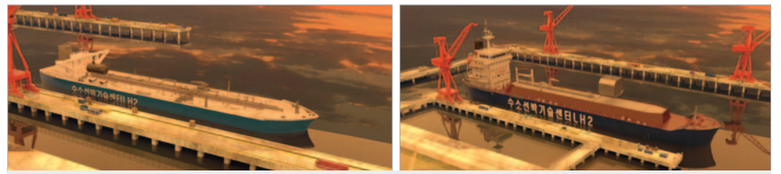
- Collaboration with LH_2 plant for performance verification
- Cryogenic insulation system performance verification
- Structural integrity & risk assessment



Mock-up performance verification using actual LH_2

Step 4. LH_2 ship Installation

Application of LH_2 storage tank to vessel



Application of LH_2 storage tank to vessel

Cryogenic Insulation Material & Storage Container Applicability Evaluation Technology Development

for Hydrogen Commercial Vehicle Operating Conditions

2021. 10. ~ 2025. 12.(51 months)

Project Operation

- **Budget** : KRW 22.6B (Government : 19.0B, Private : 3.6B)
- **Supervising ministry / Implementing agencies** : MOTIE / Pusan National Univ. + 11 partners

Objectives

- Cryogenic insulation material & storage container applicability evaluation technology development (hydrogen commercial vehicle)

Project Scope

- Material performance evaluation technology development
- Storage container performance & applicability evaluation
- Storage container evaluation simulating vehicle operating conditions
- Analysis-based evaluation technology & monitoring system development



01
- Heat flux measurement-based effective insulation performance evaluation facility fabrication & operation
- Insulation material performance evaluation method development, standards & procedure establishment

02
- Storage container BOR/Holding Time evaluation facility fabrication & operation
- LH_2 storage container performance evaluation standards & procedure establishment

03
- BOG analysis-based container evaluation technology
- LH_2 storage container integrated monitoring system development

04
- Vehicle operating condition simulation evaluation device fabrication & operation
- LH_2 storage container internal pressure performance & leakage evaluation

Applied Material & Developed Sensor Performance Verification under LH_2 Operating Conditions

2024. 07. ~ 2028. 12.(54 months)

Project Operation

- **Budget** : KRW 26.3B (Government : 19.5B, Private : 6.8B)
- **Supervising ministry / Implementing agencies** : MOTIE / Pusan National Univ. + 15 partners

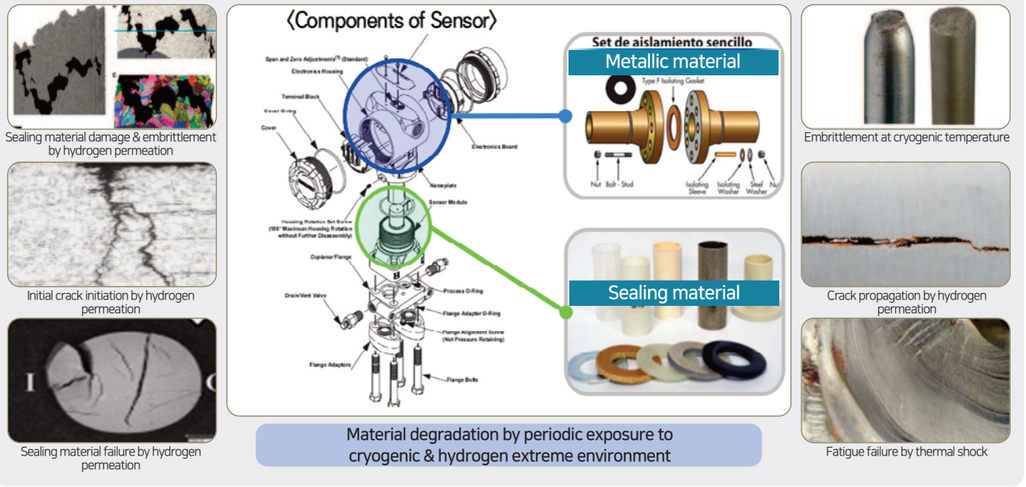
Objectives

- Developed sensor material & performance verification through cryogenic liquefied gas storage environment simulation test-bed establishment

Project Scope

- LH_2 storage system measurement sensor material safety evaluation (test-bed establishment & linkage)
- Developed sensor performance verification in LH_2 environment (temperature, pressure, flow rate, level, volume calculation S/W)

Expected Sensor Damage Diagram in LH_2 Environment



High-Performance Material Development for LH_2 Storage Tanks

2024. 07. ~ 2030. 12.(78 months)

Project Operation

- **Budget** : KRW 34.3B (Government : 25.9B, Private : 8.4B)
- **Supervising ministry / Implementing agencies** : MOTIE / Pusan National Univ. + 16 partners

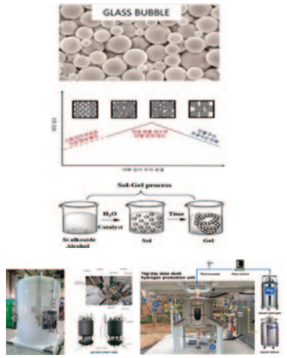
Objectives

- Insulation material technology development for spherical C-Type tanks for LH_2 carriers

Project Scope

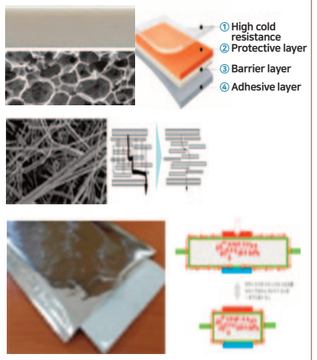
- Insulation powder material & vacuum insulation material development for LH_2 insulation systems
- Cryogenic environment insulation system design & evaluation technology development

World-class Large-Particle Powder Insulation Material Development



- Development of 200μm-class large-particle semi-dense insulation material & applications for reducing vacuum insulation system fabrication time

World-class Vacuum Insulation Material Development



- Vacuum insulation material design & constituent material development for securing cryogenic 1.3mW/m·K insulation performance / stability

Vacuum Formation Time Prediction & Cryogenic Insulation Performance Evaluation Technology Development



- Standardization of cryogenic & vacuum environment evaluation technology for powder insulation material optimized for spherical C-Type tanks

Cryogenic Piping Performance Evaluation & Certification for LH_2 Transport

2024. 10. ~ 2028. 12.(51 months)

Project Operation

- **Budget** : KRW 21.1B (Government : 15.9B, Private : 5.2B)
- **Supervising ministry / Implementing agencies** : MOTIE / Pusan National Univ. + 16 partners

Objectives

- LH_2 carrier piping performance verification & test DB securing

Project Scope

- Cryogenic piping material safety evaluation for LH_2 transport
- Piping verification system securing in cryogenic environment
- Developed piping performance verification & certification acquisition support considering LH_2 operating conditions

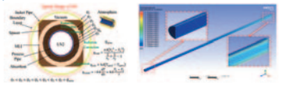
Piping Verification System Securing

| Piping test procedure development



- Performance verification procedure establishment for hydrogen embrittlement by liquefied gas impregnation
- Piping structural integrity evaluation & onshore test procedure development

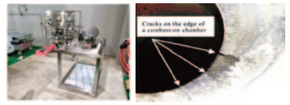
| Performance verification & analysis system establishment



- Analysis verification methodology definition & insulation performance test / fatigue process analysis execution
- Dual-piping onshore performance system establishment linked with existing infrastructure

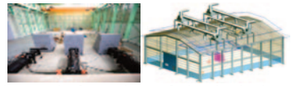
Piping Stability Evaluation

| Hydrogen / cryogenic environment performance evaluation



- Performance degradation analysis of piping / welded members by hydrogen permeation
- Piping degradation performance verification by liquefied gas exposure / impregnation

| Structural stability evaluation



- Structural safety evaluation for bending load, external impact & fire accident conditions
- DB establishment through impact resistance & internal pressure performance evaluation

Onshore / Offshore Performance Verification

| Developed piping demonstration infrastructure establishment



- Subproject 2 developed piping vacuum level, vacuum leakage rate & internal pressure performance analysis
- Developed product performance verification through comparison with overseas advanced products

| Performance verification through onshore / offshore demonstration



- Offshore demonstration execution linked with LH_2 transport project
- Onshore-verified piping offshore installation & commissioning support

Material Technology Development for Hydrogen Fuel Engines

2024. 07. ~ 2027. 12.(42 months)

Project Operation

- **Budget** : KRW 17.2B (Government : 13.9B, Private : 3.3B)
- **Supervising ministry / Implementing agencies** : MOTIE / Pusan National Univ. + 14 partners

Objectives

- Large-capacity eco-friendly internal combustion engine performance evaluation system establishment & hydrogen fuel injection device development

Project Scope

- Internal combustion engine hydrogen fuel injection device & supply system material application technology development
- Material degradation behavior demonstration & mechanism under actual operating conditions of hydrogen fuel systems

	Material Property Evaluation	Hydrogen Material Degradation Mechanism Elucidation	Material Application Technology Development
Strategy	Material property evaluation & degradation DB establishment under hydrogen internal combustion engine operating conditions	Material property testing & simulation-based hydrogen-induced degradation mechanism analysis	Material design with physical / chemical properties & mechanical performance suitable for target equipment
Key Activities	- Material hydrogen embrittlement behavior evaluation & DB establishment under hydrogen internal combustion engine operating temperature / pressure combined loading - Tensile, fatigue, fracture behavior, wear, etc.	- Damage simulation technology development including hydrogen embrittlement for candidate materials - Hydrogen permeation stability securing & evaluation technology development for non-metallic materials in hydrogen supply / injection devices	- Material evaluation procedure / material selection procedure development for hydrogen internal combustion engine core equipment - Statistics / fracture mechanics-based residual life prediction method development for hydrogen internal combustion engine key materials

Hydrogen Ship Safety Standards Development Project

2020. 04. ~ 2024. 12.(57 months)

Project Operation

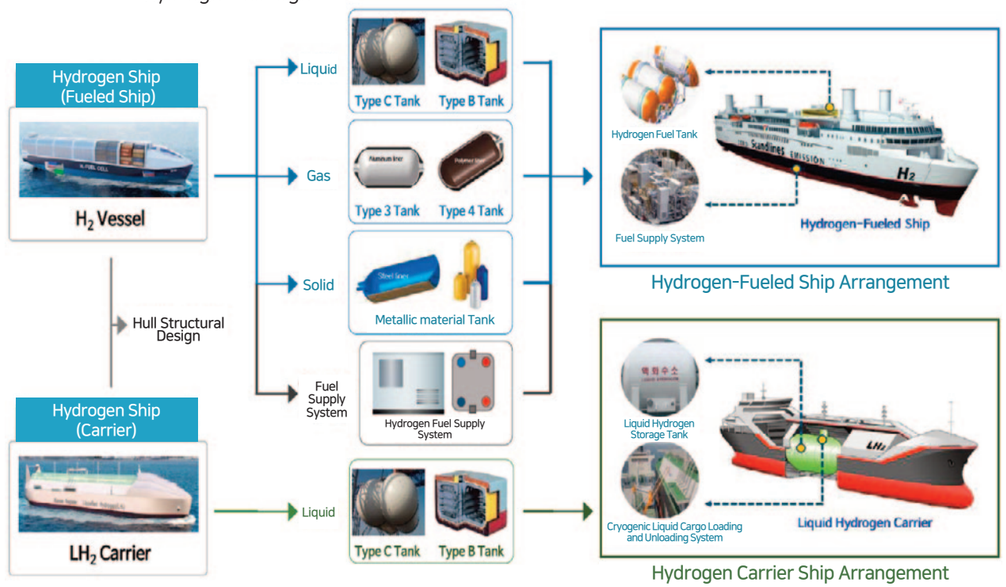
- **Budget** : KRW 15.7B (Government : 12.3B, Private : 3.4B)
- **Supervising ministry / Implementing agencies** : MOTIE / Pusan National Univ. + 9 partners

Objectives

- Hydrogen storage container & fuel supply system safety standards development for ships
- Hydrogen leakage prevention & damage mitigation technology development

Project Scope

- Hydrogen storage container (liquid, gas, solid) & fuel supply system safety standards development for ships
- Classification technical standards development for hydrogen-fueled ships (fuel supply system) & carriers (LH_2 containment sys.)
- Ship hydrogen leakage prevention technology development & evaluation system establishment
- Ship damage mitigation technology development & evaluation system establishment for hydrogen leakage



Establishment of Convergence Graduate School for LH_2 Storage & Transport Mega System



Multidisciplinary

Ability to acquire knowledge across major & other fields and utilize multidisciplinary knowledge in a convergent manner

Industry Convergence

Knowledge utilization & experience sharing through communication with industry

New Knowledge Creation

Capability to open new possibilities for application to new disciplines or industries and ultimately contribute to new value creation

Need for Technology Convergence in LH_2 Storage & Transport Mega System

- Growing importance of establishing overseas hydrogen import infrastructure such as LH_2 carriers & hydrogen ports utilizing 'K-Shipbuilding' strengths
- Growing need for establishing hydrogen-specialized advanced education programs & industry transition retraining
- Currently contributing to industrial transition of mega systems, which are high-value-added energy supply chain infrastructure, into high-value-added products
- Increasing demand for ICT technical workforce in related fields due to energy infrastructure scaling, AI & digital twin technology application attempts
- Growing demand for energy+ICT convergence workforce beyond traditional major workforce

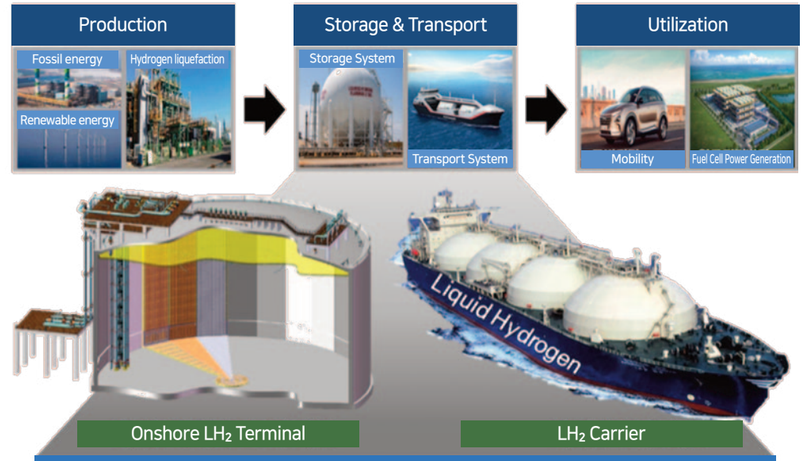
Need for Convergence Talent Development through Convergence Graduate School Establishment & Operation

- Need for self-reliance in key sub-technologies to lead in new energy industry
  i.e., need for university-level energy+ICT customized talent development reflecting industry trends
- Core technologies for LH_2 carrier development include ship construction, insulation system development, ICT-based control — requiring multidisciplinary convergence research across naval architecture & ocean engineering (ship design & construction, liquefied gas handling), electronic & electrical engineering (system control), materials engineering (insulation material development), industrial engineering (technology mass production, commercialization)

LH_2 Industry Revitalization based on Convergence Graduate School

Preempting LH_2 Global Supply Chain

- Resolving hydrogen economy technology & workforce shortage and preempting LH_2 global supply chain through establishment of 'Convergence Graduate School for LH_2 Storage & Transport Mega System'



Large-Capacity LH_2 Storage & Long-Distance Maritime Transport Mega System

Outstanding Convergence Technical Workforce Development

- Convergence graduate school establishment with 4 participating departments
  - Naval Architecture & Ocean Engineering: Ship & storage system design & construction, liquefied gas handling system
  - Electronic & Electrical Engineering: ICT-based mega system control
  - Materials Engineering: Cryogenic insulation system material development
  - Industrial Engineering: Commercialization technology for LH_2 mega system equipped with new technology
- 3-Track strategy talent development education program

Collaboration with Top-level Research Institutions

- HSTC + 3 joint institution establishment
- Participation of major hydrogen industry companies

Regional Innovation Strategy based on Local Government-University Cooperation (RIS)

Vision

- Busan-based hydrogen professional talent development for undergraduate / graduate students through systematic education & curriculum specialization in the Busan region
- Responding to government hydrogen mobility revitalization policy through establishment of local industry-academia cooperation governance in the Busan region

Objectives

- Finalizing details including curriculum composition & completion plan covering full hydrogen lifecycle, degree program operation, etc.
- Providing opportunities including company visits, practical training, etc. beyond hydrogen shared university program completion

Composition

- **Administrative support** :
  Busan Technopark, Dong-A Univ. RIS Project Group, Busan LINC 3.0 Project Group
- **Operation lead** : Pusan National Univ. HSTC, Pusan National Univ. LINC 3.0 Project Group
- **Participating universities (institutions)** : 12 universities in Busan, Korean Register (KR), Busan Hydrogen Alliance, hydrogen-related R&D companies / institutions

3-Track Talent Development Program

Hydrogen Storage / Transport Track

- (Convergence Basic) High-pressure hydrogen storage technology
- (Convergence Basic) LH_2 carrier understanding
- (Convergence Advanced) Hydrogen storage alloy technology
- (Convergence Advanced) Chemical hydrogen storage technology

Hydrogen Production / Liquefaction Track

- (Convergence Basic) Introduction to hydrogen production
- (Convergence Basic) Hydrogen liquefaction process design
- (Convergence Advanced) Refrigerator design
- (Convergence Advanced) Water electrolysis handling engineering

Hydrogen Safety / Policy Track

- (Convergence Basic) Hydrogen performance evaluation infrastructure
- (Convergence Basic) Hydrogen plant supervisor
- (Convergence Advanced) Hydrogen energy ISO standardization
- (Convergence Advanced) Hydrogen safety & licensing

Hydrogen Ship Big Data Platform Construction Project

2022. 11. ~ 2023. 10.(12 months)

Project Operation

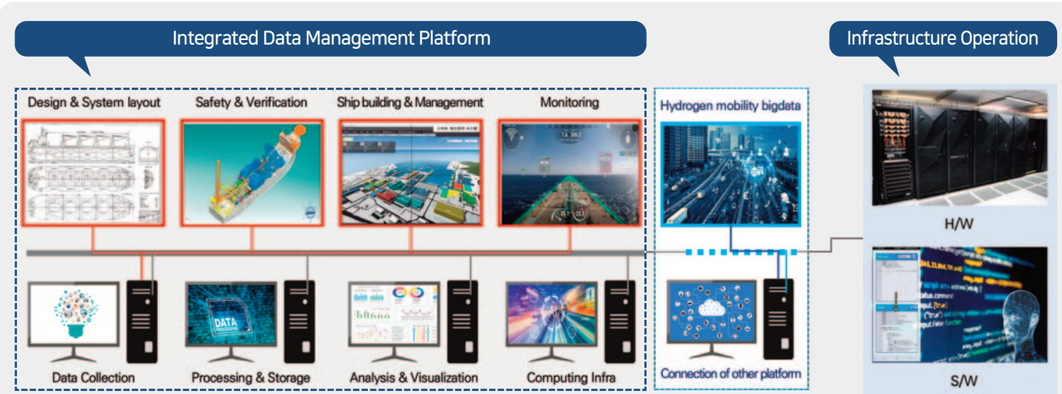
- **Budget** : KRW 1.4B (Government : 0.8B, Municipal : 0.6B)
- **Supervising ministry / Implementing agencies** : MOTIE / Pusan National Univ. + 4 partners

Objectives

- Hydrogen ship big data platform design for public interest & sharing purposes
- Hydrogen mobility & infrastructure big data integrated network establishment

Project Scope

- Big data platform pilot design
- Hydrogen ship big data platform operation base establishment
- Hydrogen ship big data standardization promotion system preparation
- Hydrogen mobility big data integrated network establishment



- Hydrogen ship navigation / sensor data management server room
- Server room-linked demonstration data control center
- Hydrogen ship monitoring & control platform
  - MAP-based ship location / status monitoring
  - Data extraction / reporting / analysis functions
  - Virtual ship creation/management / integration system
  - Laboratory equipment data interface



Hydrogen Ship Technology Forum

Purpose

- Joint response to eco-friendly ship market including hydrogen fuel ship transport & utilization

Job Creation
Shipbuilding & equipment co-growth

Enterprise Development
SMEs with core technologies

New Industry Creation
New Industry Creationogies

Technology Concentration
Forward & backward industry capability strengthening

Functions

- Industry-academia-research-government council for securing localization technology

Hydrogen ship joint technology development	Core technology / product localization
Technology & safety standards, policy development & consulting	Network establishment / hydrogen utilization popularization

Structure

- Related central government ministries, local governments, industry, academia, research & related institutions (approx. 300 organizations)

Forum Steering Committee
- Co-chairpersons (2)
- Co-chairs (6)
- Standing Planning Chairper-

→ Supreme Decision-making Body

Forum Secretariat

→ - Steering committee decision execution & administrative support
- Forum operation
: Supervised by standing planning chairperson

Working Groups
- Metallic Materials
- Insulation & Composite Materials
- Equipment, Parts & Devices
- Standardization Support
- Ship Operation

→ - Execution body centered on civilian appointed members
- Purpose-based industry-academia-research & related institution participation

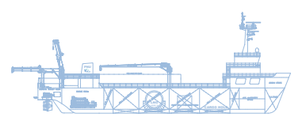
Domestic & International Industry-Academia-Research Network

Domestic Research Institutes

- Korea Institute of Machinery & Materials (KIMM)
- Korea Institute of Materials Science (KIMS)
- Korea Research Institute of Ships & Ocean Engineering (KRISO)
- Research Institute of Medium & Small Shipbuilding (RIMS)
- Korea Institute of Industrial Technology (KITECH)
- Korea Marine Equipment Research Institute (KOMERI)
- Korea Atomic Energy Research Institute (KAERI)
- Korea Automotive Technology Institute (KATECH)
- Korea Electrotechnology Research Institute (KERI)
- Korea Testing Laboratory (KTL)
- Korea Testing & Research Institute for Chemical Industry (KTR)

Domestic Companies

- Samsung Heavy Industries
- Hanwha Ocean
- HD Korea Shipbuilding & Offshore Engineering
- Hyundai Motor Company
- Samsung C&T
- Doosan Enerbility
- Doosan H2 Innovation
- POSCO
- Hyundai Steel
- Panasia
- HJ Heavy Industries
- Dongsung Finetec
- Korea Carbon
- Sejin Heavy Industries
- Techross Co., Ltd.
- Dongwon Entech Co., Ltd.
- Halla IMS
- Mt.H Control Valve Co., Ltd.
- BHI
- Macron
- Samwoo MCP Co., Ltd.
- Daechang Solution
- Movena
- KmsEmec
- Parity
- Jungwoo INE
- Seojin Instech
- Hantech Co., Ltd.
- Shinil Ace
- Surim Tech
- Dongbang Sunki
- Ilseung Co., Ltd.
- Daehak
- Sunbo Industrial Co., Ltd.
- Ablacs Co., Ltd.
- YL Energy Technology Co., Ltd.
- Kelix Tech Co., Ltd.
- Busan Hydrogen Alliance (47 Companies)



Overseas Universities / Research Institutes / Institution

- Carnegie Mellon University
- The Pennsylvania State University
- Georgia Institute of Technology
- University of Wisconsin-Madison
- Purdue University
- Fraunhofer
- University of Southampton
- University of Strathclyde, Glasgow
- University of Twente
- Norwegian University of Science and Technology
- Technical University of Munich
- Paul Scherrer Institute
- Peking University
- Nanyang Technological University
- Stanford University
- Missouri University of Science and Technology
- The University of Texas at Austin
- Argonne National Laboratory
- Yale University
- University of Connecticut
- NASA
- Colorado School of Mines
- Harvard Medical School
- HyAxiom, A Doosan Company
- Lloyd's Register
- American Bureau of Shipping

Domestic Public Institutions

- Korean Register (KR)
- Korea Gas Safety Corporation (KGS)
- Korea Hydro & Nuclear Power (KHNP)
- Korea Maritime Cooperation Center
- Busan Marine Equipment Industry Cooperative
- Busan Technopark
- Gyeongnam Technopark
- Ulsan Technopark

